Technologies for Social Inclusion in Latin America. Analysing opportunities and constraints; problems and solutions in Argentina and Brazil

Hernán Thomas and Mariano Fressoli

Abstract— **Brazil and Argentina have managed to grow almost continuously since 2003 and to sustain partial improvements in a number of social indicators: poverty, unemployment, access to basic services, and primary education. At the same time, Argentina and Brazil have increased their R&D expenditure and set new priorities as regards training of human resources in Science and Technology. However, this scenario contrasts with the persisting inequality in income distribution, as well as with the persisting structural shortcomings (decent housing, transport, access to sanitation services, power and environmental problems, etc.). This contrast raise questions over the relation between S&T policy strategies and its effects on social inclusion: Are current welfare policies sufficient for eliminating social exclusion? Which role does Science and Technology policy play in solving social problems? And, more importantly: Is it possible to propose alternative social-inclusion strategies? Is it possible to turn locally generated scientific and technological knowledge into feasible solutions for the region? This paper will undertake a critical analysis of the strategies for fighting social exclusion currently applied in Latin America with regard to Science and Technology policy and the local production of technologies aimed at social inclusion.**

***Index Terms*— Inclusive innovation – Argentina – Brazil – S&T policies**

I. Introduction

Brazil and Argentina are two of the most dynamic countries in social and economic terms in Latin America. Both countries have managed to grow almost continuously since 2003 and to sustain partial improvements in a number of social indicators: poverty, unemployment, access to basic services, and primary education. At the same time, Argentina and Brazil have increased their R&D expenditure and set new priorities as regards training of human resources in Science and Technology. These elements seems to point out a political window of opportunity, related to the rising of centre-left governments in the region, the continuous grow of national gross product and the rising value of exportable regional commodities. This scenario, which had not been there in the last four decades is a key opportunity to solve the region's exclusion problems.

However, this scenario contrasts with the persisting inequality in income distribution, as well as with the persisting structural shortcomings (decent housing, transport, access to sanitation services, power and environmental problems, etc.).

Are current welfare policies sufficient for eliminating social exclusion? Which role does Science and Technology policy play in solving social problems? And, more importantly: Is it possible to propose alternative social-inclusion strategies? Is it possible to turn locally generated scientific and technological knowledge into feasible solutions for the region?

The scale and complexity of these challenges is maybe beyond typical answers and conservative approaches in S&T. Furthermore, in order to answer these questions it seems inevitable to experiment with new policies, new theoretical approaches which could bring some innovative answers to old and resilient problems. The challenge is then to explore the abilities to design housing, to manage the use of natural resources, to build infrastructure, to produce and distribute food, to communicate and have access to cultural heritage, to create decent jobs. This is because the abilities to design new strategies in terms of scientific and technological knowledge production, new forms of production and distribution of goods and services will determine what kinds of life are and are not viable in Latin American societies.

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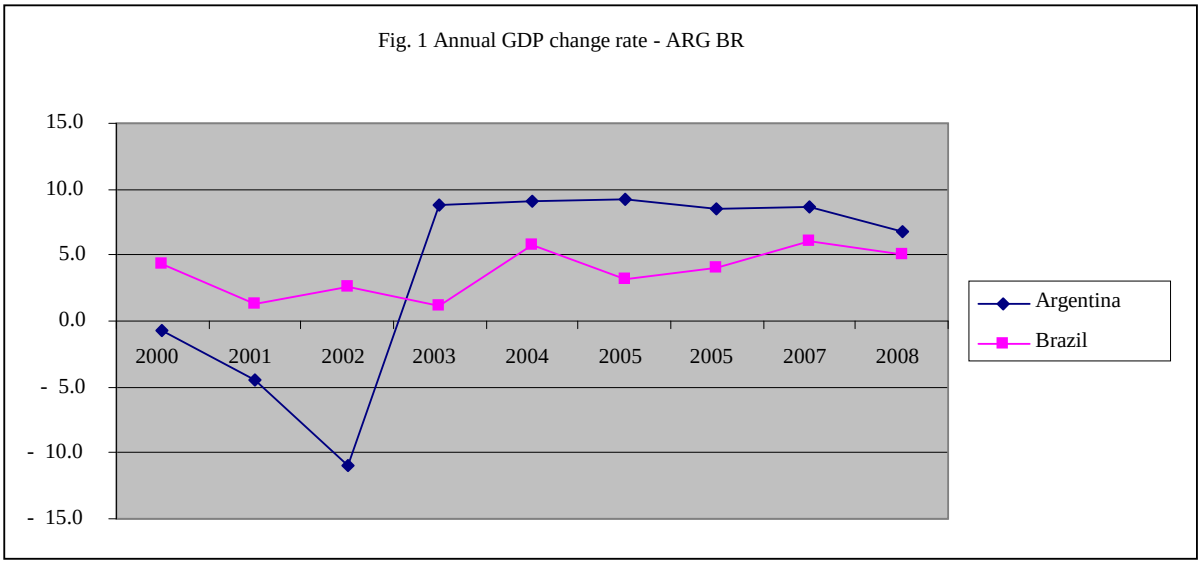
The aim of this article is to revisit the mainstream policy of Science, Technology and Innovation currently been developed in Argentina and Brazil. As result of this analysis we will propose new elements for the conception of a new politics for development with social inclusion based on the design of new Social-technological systems. The concept of Technologies for Social Inclusion will be central to this proposal. Technologies for Social Inclusion is a way of developing and implementing technology aimed to generate social and economic dynamics of social inclusion and sustainable development. It also implies new forms of democratization of Science and Technology, more space to local knowledge in acknowledging social needs and capabilities, and encouraging process of co-construction of technologies and looking to reinforce ways of participation and accountability in the process of innovation. But, far from being isolated cases, Technologies for Social Inclusion should be thought as Social-technological systems. This is what we will try to explain along this article.

The first part of the article (sections 2 through 4) reviews the current scenarios with regard to economic growth, local Science and Technology systems, and the persistence of structural exclusion problems. The second part (sections 5 through 6) examines the issues relating to the inadequacy of local Science and Technology agendas concerning population needs and the problems involved in the performance of currently available technologies for social inclusion. The third part (sections 7 through 8) addresses two strategic aspects of the potential solution: the need for new conceptual and regulatory development, and the opportunity for undertaking new technological developments, which suit the scale and scope of the region's social challenge.

II. Scenario 1: Growth and Poverty Reduction

As from the 2002-2003 period, Argentina and Brazil have achieved a virtually continuous growth, only briefly interrupted in 2008-2009 as a result of the international financial crisis. Thus, after the acute economic crisis faced by Argentina in 2002, its GDP has grown at an average 8.5% rate between 2003 and 2008. Brazil also saw its GDP fall in 2003 to rise later in the same period at an average 4.1% [1].

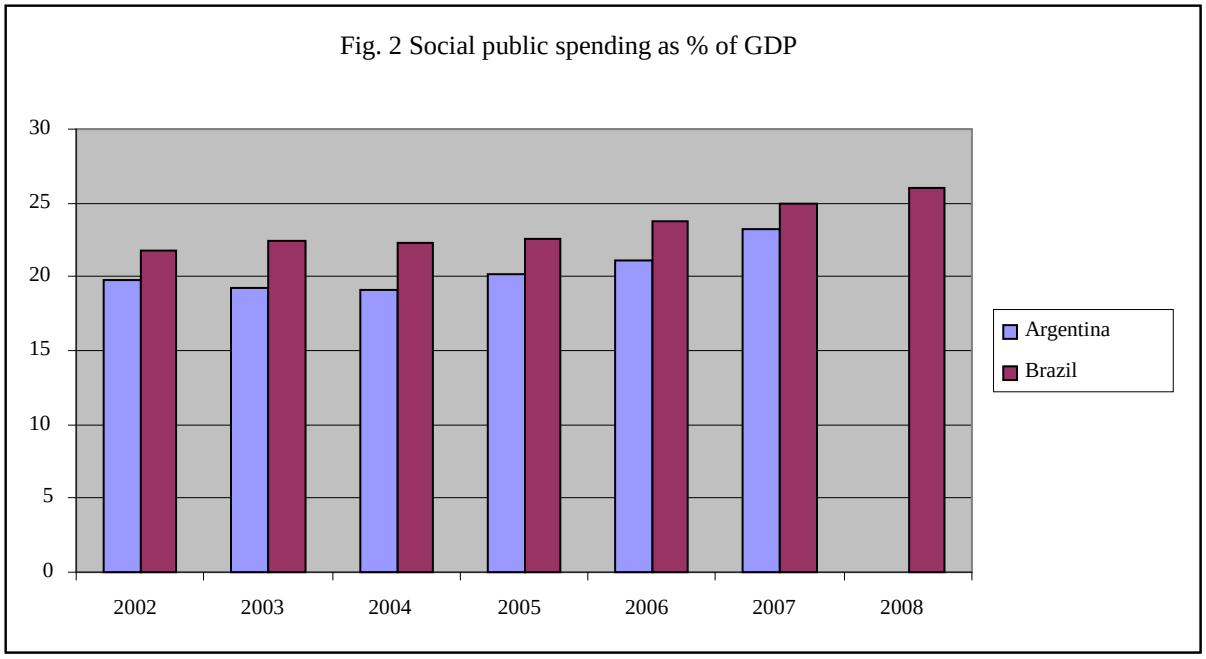
Fig. 1 Annual GDP change rate - ARG BR



Source: ECLAC [1]

The current economic strength of both countries is characterised by the maintenance of high growth rates, trade and current-account surplus, an increasing independence from foreign financing markets, higher cash reserves and a lower external debt burden, reduced unemployment, a stronger domestic market, and the creation of new social policies [2], [3], [4].

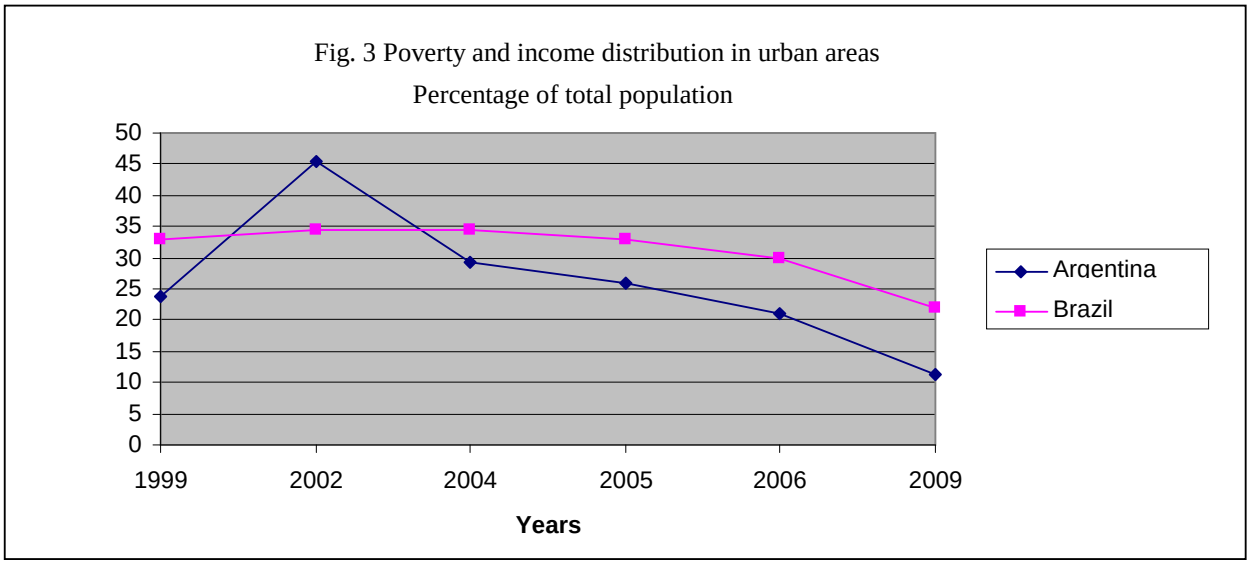
Two points in this sustained growth process are relevant for this paper. First, both countries show a decrease in poverty. This can be explained by a combination of factors, including the sustained growth of GDP and increased social spending. Thus, the percentage of GDP aimed at public social spending has been increasingly growing in Argentina and Brazil, exceeding 23% in 2007 in both cases.



Source: ECLAC [5]
Note: Data for Argentina for 2008 is not available

Per capita public social spending reached 2,000 dollars in Argentina and approximately 1,000 dollars in Brazil during 2006-2007[5].

The results of the new social policy are remarkable. Poverty has been steadily decreasing since 2002, from 45.4% of the population in Argentina and 34.4% in Brazil, to 11.3% and 22.1% respectively in 2009. Meanwhile, urban indigence fell from 20.9% in Argentina and 10% in Brazil to 3.8% and 5.5% respectively during the same period [1].



Source: ECLAC [1]

As shown above, fighting poverty has become an explicit and top-priority goal in both countries. Argentina and Brazil are not only allocating larger resources but are also implementing new social programs. Therefore, in line with other efforts at the regional level [5], they have developed poverty-reduction programs such as *Bolsa Familia* (Family Allowance) in Brazil, and *Asistencia Universal por Hijo* (Universal Child-Based Aid) in Argentina.

But, at the same time, it is necessary to examine the contents and approach of these programs: quick-effect welfare interventions, most of them in line with conditional cash transfer strategies. Moreover, it is necessary to consider the impact of such exclusion-fighting programs on the indicators themselves. For instance, part of the explanation for the reduced

unemployment rates stems from the implementation of precarious-work programs, distributed according to a welfare approach, at the state or municipal level. Unemployment (and, to a lesser extent, underemployment) has relatively dropped, but job quality –in terms of employment stability, precariousness, training, and standard of decency— has not improved.

III. Scenario 2: Strengthening of the Public Science and Technology Research System

The second relevant aspect of the recent growth process in Argentina and Brazil lies in the greater attention both countries have been paying to the development of their Science and Technology policies. This has implied the steady growth of R&D investment, an increase in the number of PhD fellowship holders and researchers and, finally, in the number of scientific publications.

Fig. 4 S&T expenditure with relation to GDP

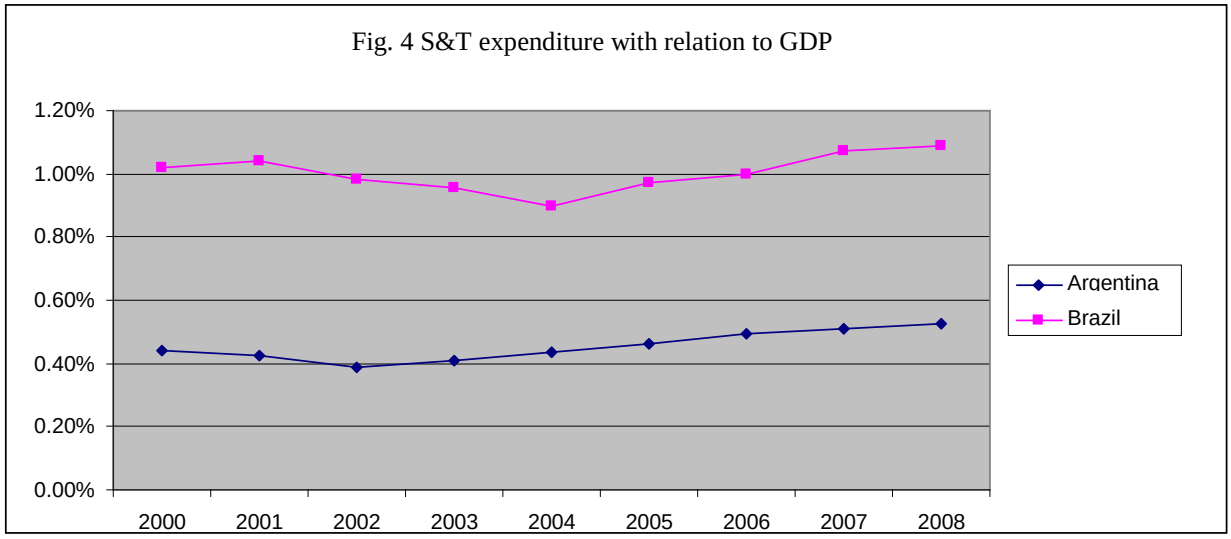
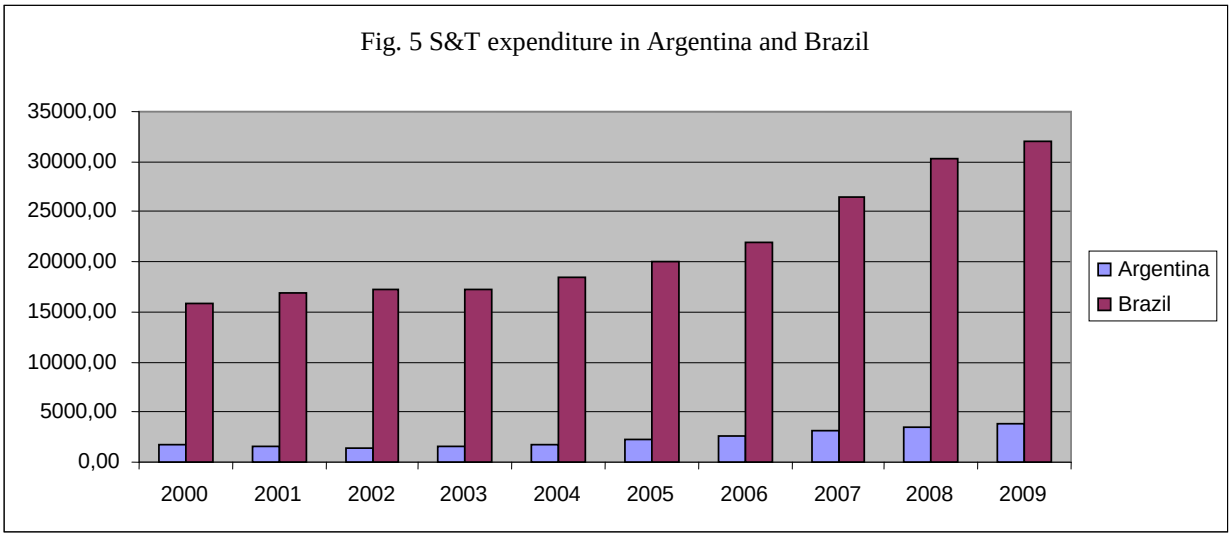


Fig. 5 S&T expenditure in Argentina and Brazil



Source: Ricyt [6]

The increase in resources (in USD millons) shows the importance assigned by these countries to the investment in S&T. Argentina has taken a significant step towards the institutional establishment of the topic through the creation, in late 2007, of the Ministerio de Ciencia, Tecnología e Innovación Productiva (Ministry of Science, Technology and Productive Innovation) [7].

At the same time, as shown in the tables below, in both countries the number of PhD fellowship holders and trained researchers has increased.

Fig. 6 Researchers (FTE)

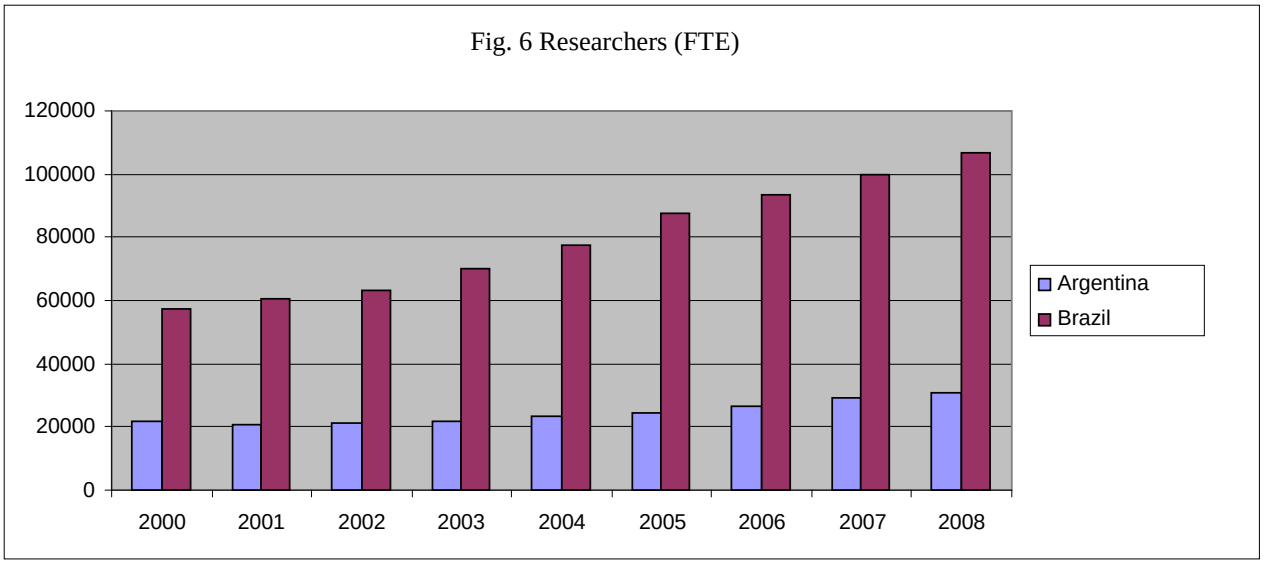


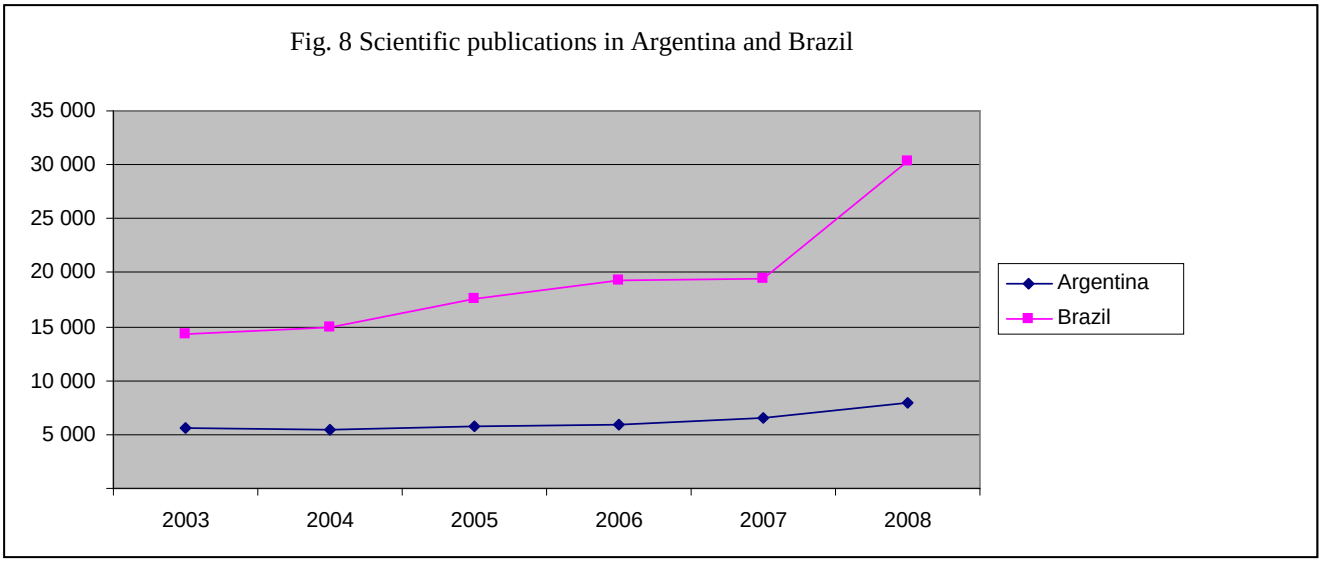
Fig. 7 PhD Fellowship holders / R&D assistants (Full Time Equivalent)

Source: Ricyt [6]

The new S&T policy in both countries has focused not only on training new researchers in top-priority areas [8], but also on repatriating researchers, in the case of Argentina (see [9], and even on attracting foreign researchers, in the case of Brazil [10].

On the other hand, the rise in the number of peer-reviewed publications included in the *Science Citation Index* is remarkable in both countries.

Fig. 8 Scientific publications in Argentina and Brazil



Source**:** Ministerio de Ciencia, Tecnología e Innovación Productiva (Ministry of Science, Technology and Productive Innovation) – Argentina [11] , and Ministerio da Ciencia y Tecnología (Ministry of Science and Technology) –Brazil [12].

Brazil accounts for over 50% of scientific publications in Latin America, and 2.7% of the total worldwide publications (see [12]).The review of S&T policy in both countries has revitalised strategic, high tech areas, such as: nuclear power,[1] biotechnology, and nanotechnology. In addition, these are areas in which bilateral cooperation is firmly established.[2]

However, considering the evolution of patent grants to residents in Argentina and Brazil, such increase in economic and human resources has failed to improve the performance of new technology generation over the last years[3]. This would seem to indicate that, despite University-Business connection efforts in both countries, the bulk of research activities is still focused on the public sphere [14], only marginally resulting in productive innovations.

Source: Ricyt [6]
Note: Latam & the Caribbean aggregates includes Argentina and Brazil.

Performance improvement in certain areas (biotechnologies relating to the production of commodities), and the development of some innovation pockets in the aerospace industry (in Argentina and Brazil) and in the oil industry in Brazil [15] have not implied a substantive alteration in the dynamics (as such, scarcely interconnected, rather weak, and reliant on the importation of embodied and disembodied technologies) of national Innovation Systems in Brazil and Argentina.

Thus, two closely related processes can be identified in the current innovation policy. First, increases in terms of budget and the number of scientists and fellowship holders have not significantly contributed to the growth of the local economies (which are expanding for reasons other than intensive use of local knowledge in products and processes). Second, the larger investment in and the upgrading of Science and Technology policy have also failed to generate a significant increase in local poverty-reduction capabilities so far.

Why these investments has not been materialized in social improvements? Some might argue that this changes are very recent and that kind of investment in S&T could take some time to "spill over" local economies. However, it seems that it is the very dynamic and inertial trajectory of local institutions that to goes against novel translations of actual investment into innovative technological solutions for social problems at local level. Some reasons for this phenomenon include —as further explained in

[1] Argentina is completing the construction of its third nuclear reactor and has already begun constructing the first locally designed, medium-power reactor prototype, CAREM. In addition, it has recently achieved equine cloning, thus becoming the third country in the world to obtain this achievement, incorporating this species to the capabilities for ovine, bovine, and caprine cloning. Argentina has also transgenic-animal construction capabilities, and is undertaking the production of bigenerics expressed as transgenic bovines.

In turn, Brazil has also started the construction of its third reactor, Angra 3, and has announced new investments in nanotechnology and in the creation of a new synchrotron (the only ones in the southern hemisphere). In biotechnology, Brazil is notable for its investment in genomics and the sequencing of the citrus pathogen Xylella fastidiosa.

[2] One cooperation institution dating back to the creation of Mercosur is the Centro Argentino-Brasileño de Biotecnología (Argentine-Brazilian Centre of Biotechnology, CABBIO by its acronym in Spanish). Argentine President Fernández de Kirchner and Brazilian President Dilma Rousseff have recently executed a cooperation agreement for the joint construction of two nuclear reactors for research purposes (see [13]).

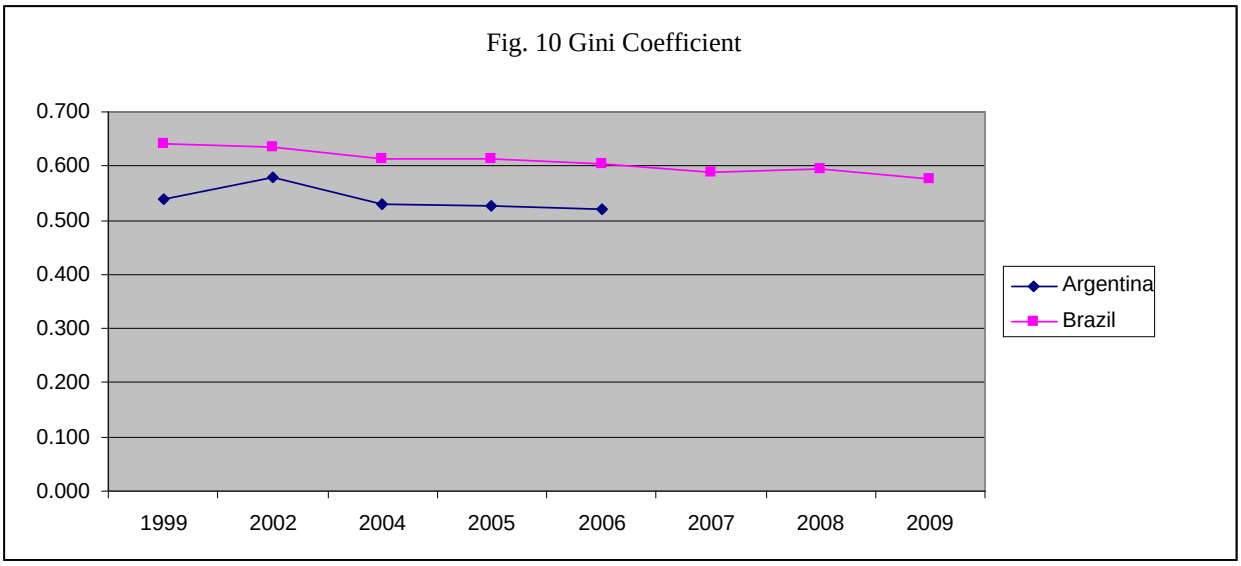
[3] Patents are not usually a good indicator in terms of dynamics of innovation. It also depend a lot of different productive sectors and its relation with intellectual property. However, at macro level can give a fair account of what is the level of forma innovation developed at public and private institutions

section 5 below— the limited, incidental relationship between state divisions/government agencies and local (public and private) Research and Development institutions; and the subordination of the great majority of research agendas in Brazil and Argentina to those of the core nations rather than to the satisfaction of local population needs.

IV. Scenario 3: Persistence of Inequality and New Challenges

The downside of the sustained growth in Argentina and Brazil is the persistence of inequality and the emergence of new social challenges. In spite of the increasing decline shown by the Gini coefficient for both countries, income inequality remains high for international standards. According to multiple indicators, Latin America has the worst income-distribution rate on Earth [5].

Fig. 10 Gini Coefficient



Source: ECLAC [5]
Note: Data for Argentina (2007-09) is not available

In this sense, various analysts have started to point out the existing difficulties for reducing the income gap, even after the implementation of the new conditional cash transfer programs such as *Bolsa Familia* (Family Allowance) or *Asignación Universal por Hijo* (Universal Child-Based Aid) [3],[5].[4]

More investment in the same solutions has not achieved the expected results. In this sense, the structural problems of poverty resist the quantitative solutions available. Growth issues in Argentina and Brazil not only show in the persistence of inequality in terms of per capita income. They also appear as problematic aspects of the population's subsistence conditions, including housing, sanitation services, and food.

Housing: Argentina has (as of 2009) an 8.7% housing shortfall in the urban area (concentrating over 70% of the population), amounting to more than 660,000 dwelling units. In Brazil (as of 2007), the total housing shortfall was approximately 6,273,000 dwelling units, 82.6% of which were located in urban areas. [5]

Sanitation Services: In 2009, 98.9% of urban households in Argentina had access to drinking water, but merely 64.2% had access to sewage services. In Brazil, in turn, available national data show that, during the same year, 84.3% of households had access to drinking water and only 52.4% to sewage services [1].

Food: While Argentina and Brazil are large food producers and exporters, the nutritional situation at the local level is highly paradoxical in both countries. According to FAO [21] data (for the 2005-2007 period), approximately 12 million people in Brazil were undernourished (6% of the population), while the nutritional shortfall in Argentina affected 5% of the population.

[4] The implementation of conditional cash transfer programs has created large expectations in governments. The results of these programs have already begun to show. Hence, the *Bolsa Familia* program in Brazil is estimated to have reduced poverty by 1.7 percentage points, from 21.7% to 20% [16]. As regards the *Asignación Universal por Hijo*, it is still difficult to assess its impact, with available estimates varying a great deal (see [2], [17]).

[5] Sources: For Argentina: Subsecretaría de Desarrollo Urbano y Vivienda (Urban Development and Housing Undersecretariat) [18], Ministerio de Planificación Federal, Inversión Pública y Servicios (Ministry of Federal Planning, Public Investment and Services) (2011) [19], based on data from the Permanent Household Survey, 2009. For Brazil, Ministry of Brazilian Cities, (2007) [20].

Furthermore, it should be taken into account that the large figures conceal enormous partial shortfalls (environmental quality, water drinkability, food intake quality, etc.).

Solving the problems of housing and sanitation-service access requires strong state investment in infrastructure. Because of the large regional differences between the two countries (as to geography, climate, access to resources and labour, etc.), suggesting universal solutions to these issues seems both difficult and inappropriate.

The solution to these problems requires the ability to develop suitable technological approaches to existing problems and resources. The technological complexity of social problems involving housing, water, and food (as well as others, including public supply of medicines, access to cultural assets, or to inclusive transport systems) shapes new social intervention spaces for new Science and Technology policy efforts.

However, both in Argentina and Brazil, public investment allocated by ministries of Science and Technology in response to social problems is still quite limited. For example, in 2008 Brazil allocated only 1.1% of government spending to R&D for Social Development [22]. In the case of Argentina, PROCODAS (the only area in the Ministry of Science, Technology and Productive Innovation explicitly focused on social problems) receives scarce funds, barely exceeding the wages of its members.[6]

The need to redirect government spending towards R&D seems obvious.

Social actors and the various state divisions —so far virtually absent from the direction of research and development agendas— should play an active role, particularly concerning publicly funded R&D (nearly 80% of the average R&D financing in the countries of the region).

Argentina and Brazil has established its key fields of scientific and technological development in high-tech areas like nuclear energy, aerospace and biotechnology, achieving an important level of expertise. Therefore, if this was done with those technologies, why not do the same with the cure of local endemic diseases, or food production, or the solution to the housing shortfall, or the power shortage, or mass extension of access to public utilities and to cultural assets. The State could set new priorities, and clear strategic lines of research, based on goals and focused on the specific solving of local social problems. And it has the necessary tools to do so, which are in principle those it has been using so far: financing, evaluation, setting of quality and relevance criteria, university education, creation and development of institutions (courses, laboratories, universities, R&D institutes).

V. Problem 1: the gap between local production of scientific and technological knowledge and local population needs

Science and Technology agendas in the region have barely focused on the needs of the local population. Vast literature agrees on the relative neglect of the social agenda by leading R&D institutions [23],[24],[25],[26],[27],[28],[29],[30],[31](to name but a few examples).

Academic production responds to extra-regional signals. The approaches to academic legitimisation, evaluation mechanisms, financing methods, institutionalised habits, and training mechanisms explain Latin American scientific communities' tendency towards self-centredness, international integration, and local isolation.

But this is no irrational behaviour. An academic researcher requires an operating structure, a relatively stable team, an institutionalised space which can only be ensured, for the time being, by their curriculum vitae, international publications, peer acknowledgment, academic background (if possible, including international degrees as postgraduate studies). In order to gather these qualifications, an academic researcher needs to undertake R&D in the fields where such production is accepted and made visible —international journals. However, these publications are typically created by scientific communities, also at the local level, but from developed countries. In turn, these communities generally respond to local signals (coming from the environment where they belong and are settled) and develop their research agendas, their academic studies and their quality and relevance criteria with regard to those signals (from their institutions, businesses, and, in broader terms, from their national or regional innovation systems).

Thus, Latin American researchers become aligned and coordinated in this fashion, round Science and Technology agendas developed outside the region. They internalise these quality and relevance criteria, and develop their careers in response to such topics, procedures, criteria and financing.

And what about local signals? The region's Science and Technology systems so far have also aligned themselves in the same direction, and based on the same rationality. And each component of those systems has been gradually emerging, becoming aligned and coordinated under this same logic in an extended fashion, on an institutional and national scale.

[6] Projects funded by "area-specific funds" (with IDB loans) are currently in progress, but the Social Development fund has not been implemented yet.

Since the 1990's, these systems have tended to incorporate innovation economy criteria, so such dynamics is in line with a "spillover logic": good science will become innovation, bringing about the relevant social benefit and development [32],[33],[34]. The latter logic reinforces the former in at least two aspects: (a) it reaffirms the delocalised perceptions of Latin American scientific communities, and (b) it legitimises in economic terms a knowledge production which only used to respond to a naive academic vision before.

The current model of Science and Technology policy causes three mutually reinforcing effects:

(a) Production of Non-Applied Applicable Knowledge (CANA, by its acronym in Spanish): knowledge characterised as "applicable" is produced but not "applied" in practice, because its production does not respond to any local need or demand[35,[36],[37]. A clear example is the case of the Chagas' disease, affecting between 18 and 25 million people in Latin America —one priority of Science and Technology systems in Brazil and Argentina which has produced considerable academic knowledge but not effective solutions to the endemic problem [38].

(b) Limited local business innovation: the increase of innovation resources has little impact on the local innovative dynamics (as shown by the evolution of patent grants in Brazil and Argentina, detailed under Scenario 2). Local businesses scarcely engage in innovation. And the rare times they do, they meet their cognitive needs with intramural resources. Thus, another one of the possible signals for local scientific communities, the demand from business, does not work in the Latin American case. It is not a "cultural" problem (neither of businesses nor of R&D public institutions). It is a structural, techno-economic issue, exceeding both local scientific communities and the State itself. Current accumulation models "need little" from locally produced knowledge.

(c) The combined action of the abovementioned effects: against the failure of the S&T policy focused on promoting local innovation, the standard response of local R&D financing systems has been to increase the funds allocated, causing a vicious circle: the more it fails, the more funds are allocated. Given these signals, R&D institutions adjust to the scenario of available resources (rather than to the one of existing needs), increasingly departing from social deficiencies and the production of higher cognitive-content solutions. In practice, the combination of these two phenomena implies missing the opportunity to use available science and technology capabilities to face the serious social problems in the region.

But, although the bulk of science, technology, and innovation policies in the region focuses on "strategic" areas subordinated to "international" agendas (such as biotechnology, nuclear power, nanotechnology, and information and communication technologies), it is also possible to notice —both in Brazil and in Argentina— a significant number of experiences in the development and implementation of technologies for social inclusion, in housing, health care, power, water, food, etc., largely exceeding the amount of R&D funds or the priority in S&T public policy assigned in governmental programs.

VI. Problem 2: the performance of "Technologies for Social Inclusion"

Besides macro statistical aspects, with high aggregation levels, it is still necessary to review another aspect of the local R&D efforts connected with social development: the production of technologies for social inclusion carried out in the region.

Which are these capabilities and which problems do they face?

Unfortunately, very few analytical studies on these efforts have been undertaken (some examples are:[39],[40,[41],[42]). Virtually none in Latin America. Therefore, over the last two years we have developed two projects in Argentina and Brazil aimed at surveying and examining the experiences in R&D, design and implementation of social inclusion technologies,[7] whose preliminary results prove significant to answer this question.

In Brazil, the bulk of the development of technologies for social inclusion centres round the Social Technology Network, a network comprising over 800 public organisations, social movements and NGOs, established in 2002, and supported by institutions such as Banco do Brasil, Petrobrás Foundation, among others. According to the survey data, only 110 of the participating institutions are engaged in R&D activities, and more than a half (53 institutions) involve research teams from universities.

According to the survey, in Argentina there are 57 institutions engaging in R&D activities concerning technologies for social inclusion, combining universities, public laboratories and, to a lesser extent, NGOs. While in Argentina there is still no coordination network, various public national institutions such as the Instituto Nacional de Tecnología Agropecuaria (National Institute of Agricultural Technology, INTA), the Instituto Nacional de Tecnología Industrial (National Institute of Industrial

[7] "Technologies for social inclusion and public policies in Latin America", International Development Research Centre (IDRC) GAPI-Unicamp. Brazil and IESCT-UNQ-Argentina, and "Ciencia y Tecnología para la solución de problemas sociales. Relevamiento y análisis de capacidades institucionales de investigación y desarrollo, producción, implementación y gestión de Tecnologías Sociales en Argentina (alimentos, vivienda, energía y salud)", FONCyT, PICT grant, 2008-2115, IESCT-UNQ.

Technology, INTI), and PROCODAS, by the Ministry of Science, Technology and Productive Innovation, have begun to consider the role of technologies for social inclusion as a key area for development.

A number of heterogeneous stakeholders participated in these experiences: NGOs, public universities, research and development institutes, target communities, governmental organisations, educational institutions, and grass roots cooperatives. The social movement has transcended politics, which is at the same time significant and problematic.

Such productions are typically marked by voluntarism rather than by strategic planning; by group or individual initiative rather than by the definition of public policies or institutional strategies (except for the housing area); implemented on a local rather than on a regional or national scale. Over a history of more than half a century of design and use of technologies aimed at solving poverty and social exclusion problems in both countries, a significant number of experiences deemed as failures can be reported.

This is because, despite the good intentions of R&D teams, and the relevance of the proposals, developing and implementing technologies for social inclusion is far from easy. The survey and analysis of experiences from Argentina and Brazil clearly show that many of them have been discontinued, or have caused significant undesirable effects, while many of them have failed (see for example:[43],[44],[45].[8] According to these authors, the biggest problem may be summarised as what might be called "specific-intervention technologies". In other terms, those developments are geared towards solving people´s problems by finding "the right" artefact. Thus, usually they relayed in low tech artefacts and in scaling down mature technologies with scarce local participation

The following tables help to refer each type of problem to its practical expression in the socio-cognitive, socioeconomic and sociopolitical areas:

TABLE 1.
IN THE SOCIO-COGNITIVE AREA

Basic planning	Stock of technologies – Singular technologies
Construction of the social problem	Exogenous process – Expert knowledge
Problem-solution relationship	Univocal – Linear – Singular – Monovariable
Technology design	Exogenous – Technical – Device-focused
Design team	Group of experts – Social division of labour
Planning and construction process	Mechanical transfer and dissemination – Adjustment to local conditions
Implied knowledge	Homogeneous – Expertise – Predominance of engineering codified knowledge
Knowledge intensity	Low – Mature technologies
Presence of tacit knowledge	Undesirable effects
User's role	Passive recipient – End of line
Users' training	*Ex-post* – Passive user

TABLE 2.
IN THE SOCIO-ECONOMIC AREA

Implicit accumulation model	Economy of two sectors – Social differentiation
Nature of the goods generated	Fixed assets
Product innovation	Indifferent
Process innovation	Applicable locally
Organisation innovation	Not considered
Assessment	Impact
Efficiency	Low tolerable efficiency – Monovariable

[8] What we call "success" or "failure" of a technology is not an ex-post result, not to mention that it is by no means inherent to the technology itself. The performance of a technology is another socio-technical construction, involving not only the various participating social groups but also the material devices of which it consists [46],[47].

Scale and scope	Small scale - Family / Community
Operating costs	Low – Unit-based estimates
Adjustment to material resources	Low-cost and/or freely available local raw materials
Technological consumerism	Undesirable – Austerity exercised through design

TABLE 3.
IN THE SOCIO-POLITICAL AREA

Type of intervention	Welfare – Mitigating
Intervention rationality	Asymmetric logic – Technologies for the poor
Local decision-making/dominance	Paternalism – Dependence on provider
Decision-making process	Top-down – Bureaucratic
S&T policy model	Supply-side – Linear – Monolithic rationality
Social impact of the intervention	Replication of social differentiation

Source: Thomas & Fressoli.[9]

Therefore, the largest proportion of technologies for social inclusion fall under this definition.

A. "Patch-up" solution: technologies appear as responses offsetting the "adverse effects" of current socioeconomic and techno-production systems. While these patches may be unavoidable as short-term, emergency solutions, they prove generally unsustainable as a long-term response.

B. Iatrogenic impact: Their after-effects have proved in some cases worse than the initial problem: freezing out differences, replication of exclusion schemes by other means, generation of new systemic problems, high risk of emergence of undesirable effects.

C. Problems in planning: The failure of many technologies aimed at social inclusion shows problems in the planning of devices and systems. Dysfunctions are not simply explained by homogeneous technical ("design errors") or social reasons ("non-adoption" of a "technically well-designed" device). The complete design of devices and systems implies, for example, some social organisation, some cognitive skills in users, some local administration. Based on what would be typically diagnosed as "implementation problems" concerning these technologies, problems in design planning, in turn resulting from technology conceptualisation problems, can be reported (described in the tables above).

The majority of these observed "adverse effects" were predictable. In other words, these dysfunctions have a direct link to the design of technology, and should be part of the "key variables board" to be considered by developers of technology for social inclusion.[10]

Having been conceived of as "technologies for the poor", they behave as relief interventions, aimed at users with low educational level, and eventually give rise to top-down dynamics and underutilize the (tacit and encoded) historically accumulated local technological knowledge. Normally, they apply simple technological knowledge and mature technologies, disregarding the new scientific and technological knowledge available.

On the other hand, having been designed as simple fixed assets, many of the technologies for social inclusion currently in use lose sight of the fact that they simultaneously create inventories and market dynamics. In fact, they routinely ignore the accumulation systems and the goods and services exchange relationships in which they are embedded and, therefore, they end up being economically unsustainable. Thus it is hardly surprising that, in the mid and long term, they have created "two-sector" economic dynamics, involuntarily crystallizing situations of discrimination and marginality, and, paradoxically, giving rise to new forms of social exclusion and disintegration.

[9] Categories used in this table belong to standarizad conceptualizations, and are common to case studies of technological change based on economy of innovation`s theories and sociology of technology.

[10] Many of these problems have already been pointed out by a variety of critical studies on appropriate technologies, or are implicit in the "grassroots", "social innovations" or "pyramid base" proposals. On the one hand, however, critical analyses are few (see [39], [40],[41],[42]); on the other, these three new proposals have not yet been subject to review.

This is why it is necessary to carry out a critical review of the concepts normally used by designers, policy makers, scientists and technologists, public officers, social activists, and NGOs members, among others, when it comes to formulating, implementing, managing and assessing technologies for social inclusion. And this is why it is necessary to generate new design, implementation, management and assessment capacities. Because we cannot afford to have technologies for social inclusion that do not work.

VII. TOWARDS NEW SOCIAL INCLUSION AND SUSTAINABLE DEVELOPMENT STRATEGIES

As shown in scenarios 1 and 2, the region has opportunities both in terms of economic policy —gains in production, exports and national budgets— and of scientific and technological policy —more scientific and technologic resources, more scholarship holders, institutional consolidation. But, also it seems difficult to maintain the same level of grow for everyone whilst keeping the actual regime of innovation. The inclusion of excluded and under-integrated population, in consumption conditions that are compatible with reasonable living and working standards, as well as the creation of the necessary housing and jobs, would imply an enormous demand of energy, materials and natural resources, with a high risk of environmental impacts and new social gaps.

This potential risk scenario implies the need to alter the techno-productive patterns in force today, and, consequently, the need to find new technological solutions for social inclusion.

Susan Cozzens et al. [48]contribute with analysis criteria to guide socio-technical interventions in the context of new development and inclusion strategies. In particular, they describe three types of inequalities associated to scientific and technological development: a) structural inequalities, such as the uneven distribution of capacities (human capital); b) representational inequalities, created in the political sphere, in access to culture or in socio-economic differences which help bring about inequalities in accountabilities, and c) inequalities in the distribution of the costs and benefits of the application of knowledge and technologies. Together, according to the authors, these form a dynamic cycle they call CARE (capacities, accountability, representation, and effects): that is, they can make up a virtuous circle (the rise in capacities for designing, implementing and managing means higher participation in technology decisions, which may contribute to expand the benefits of technology and reduce its adverse effects) or a vicious one (the lack of capacities undermines the assessment and participation in spheres of science and technology decisions, and increases the exposure to the negative effects of the adopted policies). From this perspective, the key element is capacity increase and distribution.

This change of perspective in the way to build strategic science, technology and development strategies makes it possible to reorganize the policy making process, taking advantage of the scenario's positive aspects, and addressing the scientific-technical and artifactual problems in a new systemic arrangement.

Firstly, that would allow for a reorientation of social expenditures, making use of the economic excess levels to solve the region's pressing social problems. At the same time, the investment in R&D could also be reoriented towards a clear and immediate social end (avoiding the problems seen with the CANA effect), and rectifying the lag between the local R&D agendas and the population's needs. Last but not least, it would make it possible to reorient R&D actions from local institutions (i.e. universities, public laboratories and public utilities companies) towards the priority production of technologies for social inclusion.

But ¿how are the material aspects of production designed, developed and implemented?

VIII. SOCIAL-TECHNOLOGICAL SYSTEMS AS KEY COMPONENTS OF INCLUSION AND DEVELOPMENT STRATEGIES

From a socio-technical perspective, the technologies for social inclusion should be linked to the building of systemic problem-solving capacities, more tan to the solving of specific deficits. Therefore, Technologies for Social Inclusion should be aimed to the creation of socio-technically adequate local production, technological change and innovation dynamics which benefit not only the poor but everyone.

In fact, as is the case with any technology, technologies for social inclusion may have a central role in the processes of social change. They may:

- Regulate spaces and actors' behaviors;
- Condition social distribution structures, production costs, access to godos and services;
- Solve social and environmental problems;
- Actively participate (have agency) in social change dynamics (whether economic, political, ideological, cultural).

Thus, this approach of the development of technologies for social inclusion posits that the solution of poverty, and exclusion-related problems is a scientific and technical challenge.[11]

Not only is it necessary to build a new scenario in terms of public policies, but also a new conceptual framework to analyze, design, produce, implement, reapply, manage and assess technologies for social inclusion.

Of course, the aim is not to amass a new stock of technologies, repeating the same logic of supply waiting to be demanded by a potential user. The S&T Push models are as inefficient in the field of technologies for social inclusion as they are in the field of the "neo-Schumpeterian" innovation [33].

A. What are the Social-Technological Systems?

It seems convenient to begin formulating these new forms of intervention as "Socio-Technological Systems", rather than as specific technologies for social inclusion. To design them as new ways to develop and implement heterogeneous socio-technical systems (for products, processes and organization) focused on the generation of dynamics of social and economic inclusion, democratization and sustainable development.

By approaching the problem/solution relationships in socio-technical terms, as a complex process of co-building, in practice, a systemic perspective is created, in which it is unlikely to find a specific solution of a specific problem. On the contrary, this systemic perspective allows for a new way to design socio-technical solutions. And, consequently, supports a change in strategic vision that implies both the creation of new ways of formulating socio-technical solutions and the design of inclusion dynamics for redefining technologies and for establishing working / non-working technologies (including or excluding technologies, sustainable or risky, public or proprietary).

Every technological system asserts itself by interacting with other systems, unfolding the advantages of inclusion in technological frameworks, scale economies, compatibility and feedback. The development of Social-technological systems in heterogeneous networks might imply obvious economical benefits: inclusion, employment, integration of service systems. In fact, several "appropriate" technologies have already produced fixed assets that have solved, to a variable degree, different specific techno-productive problems.

Unfortunately, still there is not any analysis available on Social-Technical Systems of this kind. Maybe, one of the closest experiences is the Rapid Transit Bus System implemented in Curitiba, Brazil from the 1970's. Driven by the aim to improve the public transport, the municipality of Curitiba designed a new model of bus for public transport. This included a new arquitecture for boarding platforms, a transformation of the network of roads, a new system of fares. What can be seen as an apparently a simple change of transports system, really implies a systemic change in the city. The modification of the network improved access to marginalized areas of the city. Index of security improved. New cultural and commercial activities aroused. The city could improve and redesigned its use of available land and grew new green public spaces. New factories of motor parts and car bodies started to be produced in Curitiba for the new designed buses. Employment grew and the city started to attract tourism. Nowadays, Curitiba exports Rapid Transit Bus technology to other parts of the world and it is considered as an international example for urban planning. Of course, this process was not planned as a whole from the beginning. But, it also could be strategically designed (for an account of Curibiba's case see [46]).

Like the example of Curitiba's transport system, a variety of Social-technological systems that offer both accessibility and flexibility in the social and environmental cost structure of healthcare, food, transportation, housing and other systems may be linked to reference pricing and cost reduction in coordination, logistics, infrastructure and services. The adaptation of locally generated Social-technological systems to their actual application, as well as their compatibility with preexisting systems, imply also a potential for expansion in third markets, in developing or even developed countries.

B. Innovation opportunities

Designing technologies for social inclusion —incorporating the inventories dimension— means creating new possibilities and opportunities, both in economic and productive terms. Far from the static invention of an "appropriate" solution, the development of Social-technological systems might imply the creation of local innovation dynamics, the opening of new product lines, of new productive businesses, of new forms of organization of production and of new opportunities for accumulation (seeking income from the domestic and international markets), as well as the rise of new economic segments, intermediate user networks and suppliers.

Product differentiation, the adaptation and improvement of productive processes, the development of new forms of organization, the incorporation of value added, the intensification of the cognitive content in products and processes are key issues when it comes to devising a change in the productive profile of developing economies as well as to prompt a structural improvement in the world population's living conditions (improvements in products and services, in the quality and quantity of

[11] In fact, the local development of knowledge-intensive technologies for social inclusion might generate a social profit from scientific and technological knowledge produced locally and underused until now (as pointed out under scenario 3 in this article).

employment, in the level of income; the incorporation into the labor market and social integration of marginalized segments, and even the rescue of local cultures, and collective and ethnic identities).

C. Wide vs restricted inclusion

The development of Social-technological systems constitutes a key aspect of the design of a feasible strategic response (both at a regional and world scale), because the world crisis has exposed both the structural fragility of the model of economic accumulation and the arbitrariness of its conceptual and institutional architecture. And, fundamentally, it has revealed its inability to offset the negative impacts of its own dynamics. In a few months' time, the number of the unemployed, poor and indigent has grown exponentially in the heart of the economies that are most identified with this model.

Social exclusion is not circumscribed to under-developed countries; it is merely more apparent and seems crueler there. However, observing the shortcomings of healthcare systems, the social integration problems and the environmental risks that riddle the so-called "developed" countries, as well as the restriction in access to goods and services, is enough to notice the inability of the market economy to solve key social issues.

This is not a sectoral problem; the solution does not lie in developing technologies for the poor, the marginalized. Social-technological systems are not, nor do they have any reason to be limited to, a palliative response, an attempt to minimize the effect of exclusion among the poor. It is much more interesting and useful to think of them as a way to enable the inclusion of the whole population in a viable, plural world.

Of course, there are priorities, both in terms of social debt and of strategic design: technologies to solve obvious exclusion issues and technologies for public services. Fully addressing this point might be beyond the scope of this article.

D. Public access and common property

In the economic dimension, Social-technological systems constitute a legitimate way to open up access to goods and services through the production of common property. In this level, Socio-Technological Systems may play three fundamental roles:

a) Generating inclusive economic-productive relationships, beyond the (circumstantial and structural) restrictions imposed by market economy;
b) Giving access to goods, beyond the restrictions imposed by take-home pay, and
c) Creating jobs, beyond the restrictions imposed by the local businesses' labor demand.

A strategic design of Social-technological systems would give material support to social change processes, solidary economic relationships, an expansion of the set of public, freely accessible goods and services, environmental damage control and a reduction of technological risks. Simultaneously, it would sanction to some extent (at least with its presence as a techno-productive alternative) discriminatory practices, disintegration processes, over-accumulation, luxury items, environmentally unsustainable production practices.

In other words, the creation of new Social-technological systems would allow the promotion of social inclusion cycles, precisely where capitalist market relationships prevent the emergence of integration processes and consolidate social exclusion dynamics. Of course, these Social-technological systems guided by social inclusion and networking criteria would make it possible to build fairer socio-economic systems in terms of income distribution, and more collaborative in terms of collective decision making. Far from being a mere enlarged reproduction, the proliferation and articulation of Social-technological systems would offer material support to new socio-economic orders.

E. Technologies and strategies for inclusion and development

The technologies for social inclusion should not be thought of as a remedy for the "market's failures" or a way to ameliorate the market economies' "unintended effects". Neither are they a symptom palliative treatment for the social suffering caused by capitalist development. Or a social expenditure aimed at giving a "solidary" direction to the spillover of economic benefits accumulated by the most dynamic sectors of national economies. Or a form of social action intended for sustaining —under conditions of bare subsistence— the mass of people excluded from the labor market.

Social-technological systems are —or should be— a key component of scientific and technological policies and of socio-economic development and democratization in Latin America. One of the clearest tendencies in the socio-technical dynamics related to capitalist development is the shrinkage of public space and the deepening of the processes of private appropriation of goods, knowledge and spaces. This appropriation goes hand in hand with new technologies for social control and behavior regulation.

On the contrary, Technologies for Social Inclusion entail the possibility of a radical expansion of public space. And public space does not merely mean parks, streets and cities, museums and government offices, but unrestricted access to goods and services, to means of production, to communication networks, to new forms of interrelation. At the same time, they imply the possibility of radically changing the actual matrix of production and distribution of goods and services, empowering excluded and marginal people, and including then no only as users or consumers but also as potential co-designers, and evaluators of new technological solutions.

Because the extended application of Social-technological systems would enable the transformation of wide areas of the economy into public spaces —into common property—, areas that are now privatized or undergoing privatization: from information circulation and availability to the transportation system; from basic food production to the distribution of medical drugs; from housing construction to the organization of educational systems.

IX. Last Remarks

This article highlights that there is an important opportunity for development and innovation in Argentina and Brazil. As has been show, the economic and academic scenarios present highly positive signs. There also seems to exist a political window of opportunity, related to the rising of centre-left governments in the region. This opportunity, which had not been there in the last four decades, is the opportunity to solve the region's exclusion problems. However, we also point that current public policies in Science and Technology in Argentina and Brazil not necessarily achieve its established goals and have poor results in terms of local development and reduction of poverty. We propose the development of Social-Technical System as an alternative strategy to take advantage of available resources in Science and Technology and design more suitable forms of solutions to local problems.

This is the opportunity to explore our abilities to design housing, to manage the use of natural resources, to build infrastructure, to produce and distribute food, to communicate and have access to cultural heritage, to create decent jobs. The abilities that will determine what kinds of life are and are not viable in our societies, who will be included and who will be excluded. Such new development strategies, which embrace Socio-Technological Systems as a key component, may be the most democratic way to design, develop, produce, implement, manage and assess the material matrix of our future.

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